

## Research Highlight

Aerosol spectra under marine stratus are often bimodal and attributable to cloud processes. Sizes at the minima between the modes have inferred supersaturations ( $S$ ) of nearby clouds (Hoppel et al. 1985, 1994). This was based on the principle that the lower critical  $S$  ( $S_c$ ) particles that produced cloud droplets were increased by 1) chemical reactions within droplets, and 2) Brownian capture of interstitial particles and coalescence among droplets. Thus, upon evaporation, the dry particles had even lower  $S_c$ . This resulted in a size/ $S_c$  gap because the higher  $S_c$  particles that did not form droplets were unchanged.

Desert Research Institute (DRI) cloud condensation nuclei (CCN) spectrometers (Hudson 1989) also now observe bimodal spectra. Unlike size distributions, CCN do not require particle composition in order to use particle hygroscopicity to convert size to  $S_c$  to estimate cloud  $S$ .

Observations showed considerable variability of the shapes of CCN spectra from very bimodal (Figure 1a) to very monomodal (Figure 1h). Spectra were categorized according to modality, as in Figure 1.

Cloud  $S$  inferred from Hoppel minima were lower than cloud  $S$ , which was inferred by comparing CCN spectra with cloud droplet concentrations. Marine Stratus/Stratocumulus Experiment (MASE; polluted California stratus) project averages were 0.15 and 0.23 percent, whereas ICE-T (Caribbean cumuli) were 0.44 and 1.03 percent. The differences were due to the fact that Hoppel  $S$  is not merely a manifestation of cloud  $S$  as is the CCN droplet comparison, but also results from the very cloud processing that creates Hoppel minima. This is because all three cloud processes that make bimodal spectra push CCN toward lower  $S_c$ .

CCN concentrations within bimodal distributions were significantly lower than those in monomodal distributions. Physical processing is implied because chemical processing should not reduce concentrations. Coalescence is the major physical process and Brownian capture is the minor process in this situation. Figure 2 indicates that in the cumulus clouds of the ICE-T project, coalescence was the dominant process because the more bimodal CCN spectra (lower modal rating) were associated with clouds with lower droplet concentrations. Figure 2 indicates chemical processes were dominant in the MASE project. This is because the chemical processes make better CCN by adding very hygroscopic material, hence lower  $S_c$  particles, which more easily form cloud droplets. As a result, more chemical processing (lower modal ratings) are associated with clouds with higher droplet concentrations.

## Reference(s)

## Contributors

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## Working Group(s)

Cloud-Aerosol-Precipitation Interactions

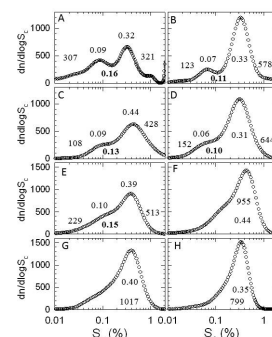


Figure 1. Differential CCN concentrations (per  $\text{cm}^3$ ) against critical supersaturation ( $S_c$ ) for MASE below cloud CCN spectra for each of the 8 modal categories. (a) cat 1, (b) cat 2, (c) cat 3, (d) cat 4, (e) cat 5, (f) cat 6, (g) cat 7, (h) cat 8.  $S_c$  in percent for, Hoppel minima are bold,  $S_c$  of processed (lower  $S_c$ ) and unprocessed modes (higher  $S_c$ ) are quantified in a-e. Monomodal spectra are quantified in f-h. Concentrations within the modes are in number per cubic cm.

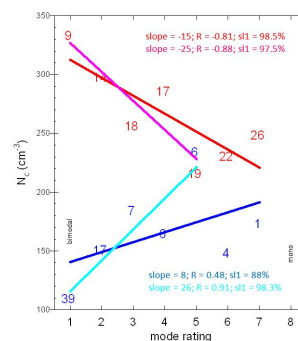


Figure 2. Mean cloud droplet concentrations against modal rating for MASE (red and pink) and ICE-T (blue and cyan). Cyan and pink regressions consider only modes 1-5.